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HOW TO MAINTAIN A STATIONARY POPULATION.

How many children must be born on the average to an American family in order to maintain the population without increase or decrease?

Dr. L. I. DUBLIN, Statistician of the Metropolitan Life Insurance Company, attempted an answer to this important question in his address as President of the American Statistical Association at its annual meeting recently held at Chicago. He pointed out that this question must be answered if we are to approach with understanding certain tendencies in contemporary American life, such as the curtailment of immigration, the drop in the birth and deathrates, the concentration of population in the cities, and the increased self-consciousness of the older race stocks. Many heated controversies in current discussion will disappear if due consideration is given to the answer to the simple question put above.

Obviously, a thousand females born today must eventually bear a thousand daughters if the population is to remain stationary. But the thousand females born today will not all bear children. Some will die in infancy and childhood. Others will live to adult age but will die unmarried and childless. Thus, the burden of bearing one thousand daughters will fall upon a fraction of the thousand females born today. Under mortality and marital conditions such as prevailed in 1920, it is found that of the one thousand females born, 788 will eventually marry. In other words, we have to reckon that the 788 married women must give birth to a thousand daughters in order to replace the original one thousand from which they sprang. To put it another way, a thousand married women must have 1,268 daughters to replace themselves.

In the same manner, making due allowance for the boys who die in infancy and childhood, and those who do not marry, we find that of the original thousand, only 742 men will be in a position to replace the original quota. These 742 men must, therefore, be the fathers of one thousand sons, or one thousand married men must be the fathers of 1,350 sons.

Combining the figures, we find that one thousand families on the average must give rise to 1,268 daughters and 1,350 sons, or to 2,618 children, and each family must, therefore, on the average, produce 2.6 children during its entire reproductive period to replace the original quota from which the parents sprang. One item has, however, been overlooked in this discussion. Not all families have children and at the present time, it is very probable that one marriage in six is either sterile or what is practically the same thing, leads to no live issue. The burden of childbearing, therefore, falls on the other five-sixths, and these families must bring into the world not an average of 2.6, but 3.1 children. This, with father and mother, makes an average of 5.1 persons, counting all the children born to fertile families (not merely those living at any moment of time).

It will be a source of surprise to many that the figure we have obtained is so large. It is, however, less than a calculation made on the basis of the 1910 figures. Under the mortality conditions prevailing at that time, the average number of children per fertile family necessary to maintain a stationary population, was 3.3. The difference of about one-fifth of a birth, or one birth for five fruitful marriages, represents a saving resulting primarily from the lowered infant mortality which occurred during the last decade. The lower the deathrate and especially the infant mortality rate, the smaller the number of children that must be born to maintain a stationary population.

The figure for 1920 has certain very definite implications. In recent decades, immigration has been, to a very large extent, responsible for the high birth rates which have prevailed in our centers of population. The average number of children born to foreign mothers has been well in excess of that which we posit as the necessary minimum for replacement. This immigration, however, has been very severely checked by recent restriction and the country can no longer count on this source for its replenishment in numbers. It was probably in the mind of the Federal legislators that the future American people shall come more and more from the older American stocks rather than from the newer strains. It is an important fact,

however, that apart from the rural areas of the country, the families representing the native born of native parentage have not averaged the number of children necessary for their replacement. In fact, wherever studies have been made of groups of urban American families, the average number of children born to a completed marriage has been well under our minimum.

The current tendency in the American birth rate is to fall even lower. It is now declining more rapidly than the deathrate. More and more, the rural populations with their still high birth rates are gravitating to the cities where the very first result is to reduce fertility. There are very obvious limitations to which such decline in the birth rate can go if the American population is to maintain its numbers and especially if its main body is to come from those stocks which recently have shown a very decided interest in the composition of the future American population.

FOUR DECADES OF PROGRESS IN DIPHTHERIA CONTROL.

The deathrate from diphtheria has responded quickly to the medical discoveries which have been made during the past thirty years for the control of this disease. The first significant contribution of medical science to the control of this important menace to child life was VON BEHRING'S discovery of antitoxin. In the period immediately following the general introduction of this adjunct in the treatment of diphtheria, 1894 to 1905, the deathrate in 23 American cities* declined at a rate of 10.4 per cent. per year. Then there came a period of diminishing returns. Between 1905 and 1918, the rate declined only on the average of 2.8 per cent. per year. This was about the same rate of decline which prevailed during the decade immediately preceding the discovery of antitoxin.

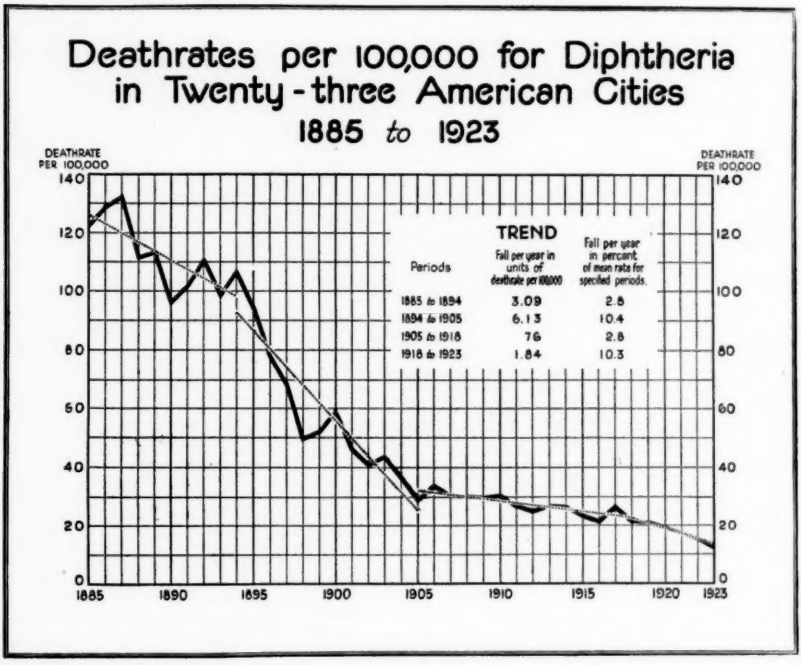
In 1918, however, the new era of SCHICK testing and the administration of toxin-antitoxin began, and with it there set in a further acceleration in the rate of fall of the diphtheria deathrate. During the period 1918 to 1923, the diphtheria rate fell on the average of 10.3 per cent. per year. This is the same rate of fall which was observed in the twelve years following the widespread adoption of VON BEHRING'S antitoxin.

The diphtheria prevailing during the past six years in these 23 American cities* exhibits also a new characteristic in the natural history of the disease. Under former conditions, the diphtheria

*New York, Chicago, Providence, Boston, Brookline, Brockton, Cambridge, Fall River, Haverhill, Lowell, Lynn, Newton, Salem, Somerville (Mass.), Baltimore, Bridgeport, Hartford, Minneapolis, Memphis, Philadelphia, Pittsburgh, Richmond, Rochester.

deathrate tended to rise and fall in three or four year cycles. During the past six years, the deathrate has declined almost by uniform annual decrements. In fact, if the prevailing rate of fall continues in the immediate future, we may expect a negligible diphtheria deathrate in the year 1930.

From the chart, we can see indisputable evidence of the effect of the labors of public health technicians and of the medical profession. The chart endorses the fundamental public health principle that



knowledge of the causes of disease leads to disease prevention and to the saving of life. The chart is an eloquent testimony to the fruitfulness of the work of the New York City Department of Health, Division of Laboratories, during the past thirty years and of the favorable impression upon the health work of other American cities which was made by the pioneer work of these technicians.

The distinguished achievements of the American public health movement with respect to diphtheria control suggest that the campaign for the suppression of other serious hazards of child life will be equally successful. The suppression of scarlet fever is the next item

in the programme of the American public health movement. Enough information is at hand at the present time to warrant a determined attack upon this disease. The scarlet fever streptococcus has been recognized, a susceptibility test exists, and preventive immunization and the production of antitoxin is possible. A chart for scarlet fever similar to that shown herein for diphtheria is being prepared. It is hoped that this chart will serve to measure future progress in scarlet fever control against the record of the disease in past years in 23 cities.

SUICIDE MORTALITY AND BUSINESS CONDITIONS.

The Metropolitan Life Insurance Company is making an inquiry into the statistics of suicides among its policyholders and in the general population, having in mind particularly the relation of suicide mortality to economic conditions. The monthly suicide data for the general population of ten cities in the Middle Atlantic States were examined and the end-results of this analysis were compared with the available facts on fluctuations in general business conditions. The following are some of the chief findings to date.

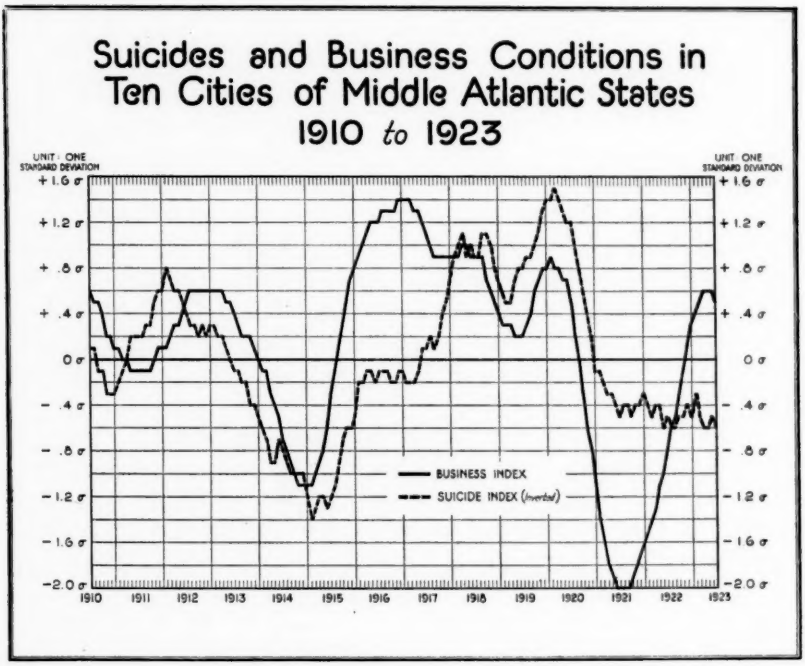
1. There was a slight downward trend of the suicide deathrate in these cities of about three per cent. per year throughout the fourteen-year period, 1910 to 1923.

2. There seems to be a fairly definite and typical seasonal fluctuation in the suicide deathrate. The minimum rates occurred in midsummer with a rise to the maximum in the spring months. The month of May had the highest rate and August the lowest. These findings relate only to the cities in the Middle Atlantic States included in this study. Different seasonal characteristics may be shown for other areas, the Pacific Coast for instance, where climatic influences are different.

3. There were certain sharp oscillations from month to month, due, perhaps, to the effect of wide deviations in weather conditions from the seasonal norm.

4. After due allowance had been made for the three foregoing factors, a series of residual values was computed which represented percentage departures of the suicide rate from norm or basic expected values, freed of long-time trend and from normal and exceptional seasonal influence. These residual fluctuations could be compared with a series of values similarly computed, expressing fluctuations in general business conditions. The chart on page 6 compares the two series.

In the long waves, there seems to be a general tendency for below-normal suicide deathrates to occur in times of above-normal business conditions. In order to facilitate comparison between the monthly items in both series, the suicide figures have been inverted on the chart. Precise correspondence, month for month, is lacking however. Thus, a falling phase in the suicide cycle set in approximately in January, 1911, and continued until February, 1912. The index for business conditions moved upward, however, from a below-normal



point in the summer of 1911 to a peak approximately in January, 1913. The downward turn for general business conditions in January, 1913, to another low point in January, 1915, was associated, broadly, with a rise in suicide frequency from a low point in February, 1912, to a peak in February, 1915. Throughout the period of improved business conditions between February, 1915, and 1917, and throughout the War and immediate post-war period, the suicide rate fell with minor oscillations to a minimum in February, 1920. With the onset of the depression of 1920-21, the suicide rate rose and since August, 1921, has shown a horizontal above-average tendency unaffected by

the temporary improvement of business conditions in 1922. Measures of the correspondence between the respective pairs of items in the two series have been computed. The coefficient of correlation, or covariation, between the suicide and business condition indices was $-.48 \pm .06$. A higher coefficient of correlation ($-.55 \pm .06$) was found when the paired items were lagged for a period of six months. In a study of the influence of the business cycle on certain social conditions, OGBURN and THOMAS, using annual series from 1900 to 1920, computed a coefficient of correlation of $-.74 \pm .07$.*

THE PROBABILITY OF DYING EVENTUALLY FROM CERTAIN DISEASES.

The right attitude toward the leading causes of death cannot be assumed from the published figures of crude deathrates. A better way of determining the emphasis upon research and upon organized effort for the control of the causes of human mortality is to find out how much the important diseases or conditions tend to curtail the life-span of persons in the productive ages. This can be done only when adequate life-table material is prepared from the crude published mortality data. In the table on page 8 we show the probabilities of dying eventually of certain diseases at ages 10 and over.

On this newer basis, heart disease leads the list of causes of death among males and females. The second disease, in point of its probability of terminating life, is chronic nephritis among males and cerebral hemorrhage among females. The disease next in order is cerebral hemorrhage for males and cancer for females. Cancer is in the fourth rank as a cause of death of males and chronic nephritis occupies this rank among females. Tuberculosis is fifth both among males and females. Lobar and broncho-pneumonia are sixth and seventh in order, respectively, for both males and females.

As we pointed out in previous BULLETINS, the effort at present expended upon the study of heart, arterial, renal and malignant diseases, is insufficient compared with the amount of suffering, disability and death occasioned each year by these diseases. A programme for the control of these conditions ought to be drawn on a scale commensurate with the nature and size of the task facing the newer public health movement. Further work is under way in this office with respect to the biological aspects of the chief causes of

*Ogburn, William F. and Thomas, Dorothy S., "Influence of the Business Cycle on Certain Social Conditions," Quarterly of the American Statistical Association, 1922, page 337.

death, the distribution over the life-span of the budget of deaths for given diseases and conditions in a life-table generation, the concentration or dispersion of mortality over the ages of active, working life, the extent to which the burden of the several causes of death at various age ranges has shifted, and the rise in importance of certain

Probability of Dying Eventually of Specified Diseases or Conditions. Calculations from Experience of United States Registration Area, 1922.

Sex; Disease or Condition	Age								
	10	20	30	40	50	60	70	80	90
Males:									
Organic diseases of heart	.1822	.1856	.1922	.2002	.2093	.2182	.2264	.2262	.1905
Chronic nephritis	.1046	.1069	.1110	.1156	.1206	.1260	.1304	.1272	.1124
Cerebral hemorrhage	.1020	.1047	.1093	.1150	.1223	.1295	.1338	.1248	.0939
Cancer	.0837	.0857	.0891	.0929	.0957	.0928	.0792	.0530	.0285
Tuberculosis	.0684	.0665	.0556	.0450	.0344	.0245	.0144	.0066	.0038
Lobar pneumonia	.0424	.0421	.0415	.0398	.0374	.0352	.0324	.0289	.0262
Broncho-pneumonia	.0200	.0201	.0205	.0209	.0214	.0227	.0254	.0313	.0328
Diabetes	.0158	.0157	.0158	.0160	.0162	.0153	.0121	.0075	.0037
Females:									
Organic diseases of heart	.1878	.1908	.1975	.2051	.2127	.2210	.2284	.2240	.1957
Cerebral hemorrhage	.1168	.1196	.1250	.1315	.1378	.1436	.1481	.1407	.1078
Cancer	.1132	.1160	.1206	.1235	.1193	.1064	.0847	.0588	.0370
Chronic nephritis	.0986	.1005	.1041	.1074	.1096	.1109	.1098	.1014	.0846
Tuberculosis	.0606	.0554	.0416	.0314	.0242	.0189	.0129	.0059	.0031
Lobar pneumonia	.0387	.0387	.0387	.0382	.0378	.0374	.0356	.0319	.0265
Broncho-pneumonia	.0263	.0266	.0273	.0281	.0295	.0318	.0356	.0396	.0418
Diabetes	.0231	.0232	.0238	.0245	.0249	.0225	.0159	.0085	.0031

diseases or conditions, and the decline for others. The life table is a powerful tool of analysis of the chances of death, and such analysis leads to altered conceptions of the task facing the life conservation movement of the future.

The present table will be supplemented by others for the experience of the Registration Area in 1910 and for the Registration States of 1900. It is hoped that when the facts are made available for these broad areas, analysts in state registration offices will prepare similar studies for their jurisdictions. In this way it will be possible to trace the effect of public health work on the chances of death in specific regions.

HEALTH RECORD FOR NOVEMBER, 1924.

The November deathrate of 7.8 per 1,000 is the lowest ever recorded for that month among Metropolitan Industrial policyholders.

The November record for every important cause of death is favorable, and particularly so for typhoid fever, for the principal epidemic diseases of childhood, tuberculosis, organic heart disease, pneumonia and puerperal diseases. Among deaths due to violent causes, suicides and automobile accidents showed increases both over October, 1924, and November of last year. There were also more homicides than in October, but there was a decline in the rate as compared with November, 1923. For all accidents combined, the rate decreased both from the October figure and from that for November of last year.

The general deathrate for the large cities of the United States during November was 12.0 per thousand. This is higher than the rate for the previous month (11.3) but is lower than the figure for November a year ago (12.2). There was reported increased sickness, as compared with October, from diphtheria, influenza, measles, scarlet fever, smallpox and whooping cough, but there were fewer cases of malaria, poliomyelitis, and typhoid fever. Comparison with November, 1923, shows that influenza, poliomyelitis, and smallpox were more prevalent this year, but that there were fewer cases of diphtheria, malaria, measles, scarlet fever, typhoid fever and whooping cough.

Diphtheria cases were more numerous in several states than in October, particularly in Alabama and Massachusetts. In the Southwestern part of Douglas County, Wisconsin, an outbreak of this disease caused the closing of three schools and a school in Sandusky County, Ohio, was closed on account of a threatened epidemic.

While there is nothing alarming in the general situation with respect to influenza, increases were reported, as compared with October, in two states, New Jersey and Texas.

Scarlet fever cases seem to be increasing in several sections of the country. In Arkansas there were 70 cases reported during the first three weeks of November, as compared with 12 for the corresponding weeks of October. In Illinois, case reports increased from 516 to 740 and in Kansas, from 206 to 746. Conditions were rather threatening in Rochester, N. Y., and many school children, with the consent of their parents, were DICK-tested and immunized. At Castalia, Ohio,

a high school was closed; a number of cases developed in Findlay, Ohio, and there was an outbreak in Methuen, Mass. At Falmouth, Ky., the High School was closed, as were picture shows and other public places. There were other outbreaks of more or less severity in Bergenfield and Newark, N. J.; Kansas City, Kan.; and Manchester, N. H. In Manchester, the Health Officer reported that the Isolation Hospital was full to capacity and that an appropriation of funds was necessary to make temporary arrangements providing for the worst epidemic of scarlet fever this city had encountered since 1889. Outbreaks of a mild type of the disease were reported from Bridgeport, Ont., and in Sylvan Lake, Alb., the school was closed.

Smallpox cases increased in several states in November. In California, 274 cases were reported during the first three weeks of November, as compared with 166 during the corresponding weeks of October. In Minnesota, the cases rose from 102 to 305 for the same weeks. In Minneapolis, 523 cases of smallpox, with 55 deaths, had been reported this year up to November 17th, and it is estimated that there are still nearly 150,000 persons unvaccinated in that city. St. Paul has been waging a vigorous vaccination campaign and in that city it is estimated that 120,000 persons have been vaccinated, with the total expected to reach 180,000. In Dublin, Ga., smallpox broke out in the negro section, but prompt efforts of the health officials appear to have completely arrested the spread of the disease. In Camden, N. J., six members of a single family were taken to the Municipal Hospital suffering from smallpox. An outbreak of a mild type of the disease occurred in Johnson City and Union, N. Y. About 30,000 vaccinations are reported to have been performed in and around Johnson City since the outbreak was discovered. The schools of St. Louisville, Ohio, and Clareholn, Alb., were closed because of smallpox.

Whooping cough appears to be becoming more prevalent. Outstanding instances are Connecticut, where case reports increased from 116 during the first three weeks of October, to 233 during the corresponding weeks of November, and Illinois, where the figures were 388 in October and 528 for the same weeks in November.

Two cases of leprosy were discovered in North Chicago, Ill., and one in New Jersey.

Up to November 12th there had occurred in Los Angeles, Calif., 36 cases of plague, with 33 deaths. The disease became prevalent in the Mexican quarter about the middle of October. A case of bubonic plague was also reported from Louisiana.

The following table shows the mortality among Industrial policyholders for November, 1924; October, 1924; November, 1923, and for the year 1923.

METROPOLITAN LIFE INSURANCE COMPANY.

Deathrates† per 100,000 for Principal Causes, Premium-paying Business in Industrial Department. (Annual Basis.)

MONTHS OF OCTOBER AND NOVEMBER, 1924, AND OF NOVEMBER, 1923.

CAUSES OF DEATH	RATE PER 100,000 LIVES EXPOSED†			
	Nov., 1924	Oct. 1924	Nov. 1923	Year 1923
TOTAL—ALL CAUSES	776.5	832.7	835.2	928.2
Typhoid fever	5.2	6.2	5.0	5.1
Measles	1.1	.8	2.3	9.5
Scarlet fever	3.6	1.7	3.5	4.4
Whooping cough	4.7	4.8	5.8	7.4
Diphtheria	13.5	11.0	17.6	15.5
Influenza	9.6	5.7	7.9	30.3
Tuberculosis (all forms)	81.2	90.6	88.9	110.1
Tuberculosis of resp'y system	71.7	80.4	80.9	99.7
Cancer	66.4	69.6	69.9	71.8
Diabetes mellitus	12.6	15.3	12.6	16.0
Cerebral hemorrhage	54.4	58.1	54.9	61.2
Organic diseases of heart	106.7	113.9	117.6	127.3
Pneumonia (all forms)	69.1	56.1	76.2	83.9
Other respiratory diseases	11.9	12.5	14.2	13.9
Diarrhea and enteritis	26.7	48.0	27.4	28.2
Bright's disease (chronic nephritis)	58.2	62.3	61.0	68.8
Puerperal state	12.1	14.7	14.0	17.7
Suicides	7.5	7.2	5.9	7.3
Homicides	7.7	7.3	8.9	7.3
Other external causes (excluding suicides and homicides)	58.1	61.4	59.6	62.9
Traumatism by automobile	17.0	16.9	16.5	15.3
All other causes	166.2	185.7	182.0	179.4

†All figures include infants insured under one year of age.

Correspondence on the subjects discussed in these BULLETINS may be addressed to: The Editor,

STATISTICAL BULLETIN,
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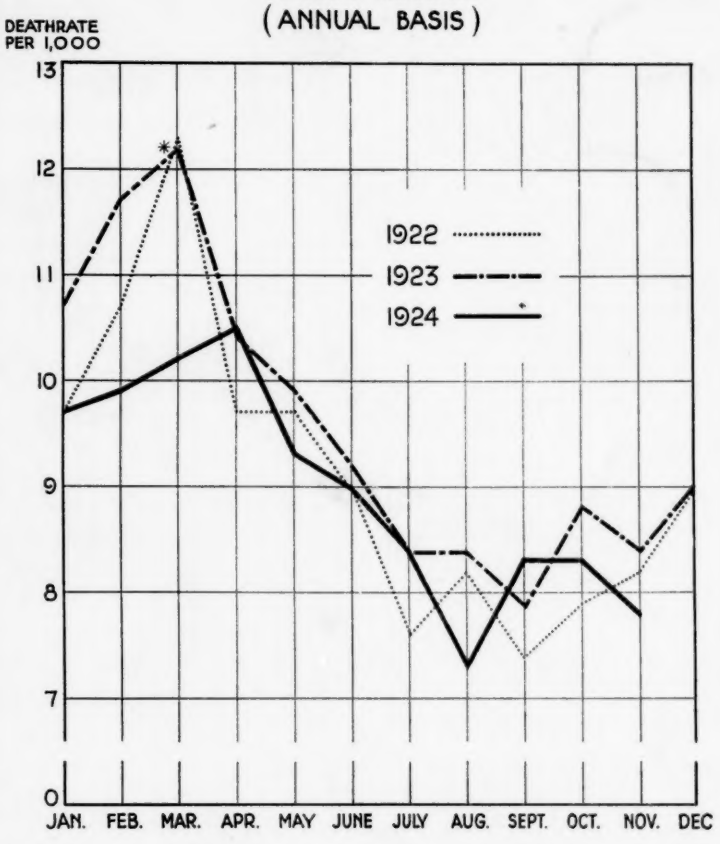
DEATHRATE PER 1,000
in SPECIFIED MONTHS *of*
1922, 1923, 1924

METROPOLITAN LIFE INSURANCE COMPANY
INDUSTRIAL DEPARTMENT
(ANNUAL BASIS)



	1922	1923	1924		1922	1923	1924
JAN.	9.7	10.7	9.7	JULY.	7.6	8.4	8.4
FEB.	10.7	11.7	9.9	AUG.	8.2	8.4	7.3
MAR.	12.3	12.2	10.2	SEPT.	7.4	7.9	8.3
APR.	9.7	10.4	10.5	OCT.	7.9	8.8	8.3
MAY.	9.7	9.9	9.3	NOV.	8.2	8.4	7.8
JUNE	9.0	9.2	9.0	DEC.	9.0	9.0	

* *Beginning with March, 1923, figures include mortality of infants under one year of age.*

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